REVIEW ARTICLE

Delay of gratification in old age: assessment, age-related effects, and clinical implications

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ABSTRACT. Delay of gratification (DoG), the ability to reject immediately available smaller rewards in favor of later larger rewards, has been a topic of continuous research interest for almost 60 years. Although numerous studies have explored this construct and its effects on wellbeing, social behavior, cognitive abilities, and academic success in children, DoG studies in adulthood and old age are scarce. Instead, delay discounting (DD), that is, the degree to which individuals devalue delayed rewards, has been used in samples of adults and older individuals, and is of particular interest in clinical studies. Findings from DD research suggest that the preference for delayed rewards increases from childhood to early adulthood, and then decreases from middle age to old age. The main aim of this review is to elucidate the importance of DoG in adulthood and old age. First, the review explores the theoretical status of DoG by specifying the relationships and distinctions between DoG and related constructs. Second, it provides an overview of DoG measurements, from traditional to novel. Third, the effects of DoG on development and wellbeing are explored. Fourth, age-related differences in DoG are summarized. Lastly, the review closes with conclusions, clinical implications, and the outlook for possible further research directions. (Aging Clin Exp Res 2012; 24: 6-14)

INTRODUCTION

If you had the choice between one marshmallow now or two marshmallows later, which would you prefer? This question from Walter Mischel's (1) original "marshmallow test" represents a dilemma which confronts us almost every day of our lives: the choice between an immediate reward and a larger delayed reward which implies the investment of time and effort. In scientific language, this behavior is termed *Delay of Gratification* (DoG) – the voluntary postponement of immediate gratification for the sake of later and better rewards (2).

DoG has been a topic of psychological research interest for almost 60 years. The DoG paradigm was inspired by the work of psychologist Walter Mischel, who is well-known for his pioneering DoG experiments. The concept was originally investigated in children, and there is only a small body of research on DoG in adulthood and old age. However, it is not only children and adolescents who choose to delay or not to delay gratification; adults and elderly people also have to make daily choices between immediate and delayed pleasures. For example, they may have to decide between spending their money (e.g., a life insurance payout) now, or saving it for their heirs. Likewise, diabetes patients may decide against delicious sweets in view of the expected health payoffs. From a lifespan perspective, practical examples are plentiful: stopping smoking to reduce health risks, or working for the gratification of a pension in old age. Thus, DoG is also highly relevant in old age.

In this review, we first describe the theoretical basis of DoG and its link to related constructs. We then provide an overview of traditional and novel assessment procedures and empirical findings with regard to the effects of DoG on cognition, motivation, social variables, and wellbeing, and summarize age-related differences in DoG. The review closes with conclusions, clinical implications, and the outlook for possible further research directions.

Key words: Age-related differences, assessment of delay of gratification, delay discounting, delay of gratification, self-regulation.

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THEORETICAL STATUS OF DELAY OF GRATIFICATION

Much theoretical work has been done to explain DoG behavior and to localize DoG in the nomological network of the related constructs of self-regulation, delay discounting, and executive function.

Self-regulation

Self-regulation, a complex multifaceted personality process, involves internal and/or transactional processes that enable goal-directed activities to be maintained (3). Both self-regulation and DoG involve the active management of goals (4). Some authors see DoG as a measure of self-regulation (e.g., 5); indeed, the DoG paradigm has been used in studies on the development of self-regulation (6). Likewise, Academic DoG, i.e., delaying gratification in order to attain academic success, and self-regulated learning strategies are closely related (7), and theories of self-regulation also draw on DoG (3). Successful self-regulation is necessarily accompanied by successful DoG – for example, when individuals prevent themselves from thinking about immediately available rewards (1). Conversely, failure of self-regulation (i.e., choosing the immediate reward) tends to be accompanied by an attentional shift to that reward (8).

Delay discounting

Humans discount the value of delayed gratification. Given the choice between two equal rewards, one immediate and one delayed, they usually take the immediate one. A delayed reward is chosen only if it is larger than the immediate one (9). DD is the degree to which an individual devalues delayed rewards (10, 11). In other words, as the delay increases, the value of the reward and hence the likelihood of its sustained choice decreases. The hyperbolic function most accurately describes DD curves for delayed reinforcers (12).

Although DoG and delay discounting (DD) are often seen as related or even identical, the empirical evidence also suggests differences between the two (13, 14). Whereas DoG calls for sustained choices, DD involves commitment choices. The "sustained choice" procedure used in traditional DoG experiments requires individuals to sustain their choice of the delayed reward during the delay period, overcoming the temptation to defect to the immediate, smaller, and continually available reward. DD procedures, in contrast, confront participants with unchangeable and separate choices for either the immediately available or the postponed stimulus on each trial (14, 15).

Executive functions

The term "executive function(ing)" covers various functions and skills that "enable a person to engage successfully in purposeful, self-serving behaviors" (16, p. 42). Executive functions include, for example, attentional flexibility (17) or inhibition (of predominant responses) (18). Executive subfunctions cooperate in goal-directed problem-solving (17) and provide the basis for making decisions, maintaining action, and regulating the self (19).

Zelazo and Müller (20) distinguished between hot and cold executive functions. Cold executive functions are primarily cognitively operated and emotionally neutral (e.g., working memory, planning), whereas hot executive functions are affectively loaded (e.g., delay of rewards, regulation of motivation and emotion, stimulus control) (21, 22). From this theoretical perspective, DoG involves hot executive functions – including the anticipation of future consequences and perseverance.

There is scientific consensus that the frontal lobes, especially the prefrontal cortex, are the neural substrates of executive functions (18, 23). More specifically, the ventromedial prefrontal cortex is seen as the brain area involved in hot executive functions, and the dorsolateral prefrontal cortex in cold ones.

ASSESSMENT OF DELAY OF GRATIFICATION – FROM THE TRADITIONAL TO THE NOVEL

Traditional behavioral assessment of delay of gratification in childhood

There are basically two traditional procedures of DoG assessment (see Silverman, [24]): First, Walter Mischel developed the *continuous measure* of DoG for studies with young children (usually between the ages of 4 and 6 years). In this procedure, the experimenter leaves the participants alone in a room with a bell and one marshmallow in front of them. The experimenter informs the children that they will get a smaller reward (usually one marshmallow or one cookie) if they call the experimenter by ringing the bell. However, if they wait until the experimenter returns (after about 20 minutes; participants were not told how long they would have to wait), they will get a larger reward (two marshmallows). The number of seconds of waiting is recorded and used as a continuous variable (1).

Second, the *dichotomous measure* of DoG involves a single question. The experimenter asks participants whether they would prefer a small reward now, or a larger reward later (e.g., in one hour). This procedure yields a dichotomous variable, as participants can only make one choice between two options (24).

Self-report questionnaires for adults

It has been proposed that DoG measures used with adults require not only meaningful delay intervals (days and weeks instead of minutes), but also meaningful and attractive rewards (25). However, it is difficult to find viable and non-trivial rewards for adults. Consequently, many researchers have used questionnaires to assess DoG in adults. Table 1 provides an overview of the self-report questionnaires available for the broad field of DoG.

Table 1 - *Self-report questionnaires assessing delay of gratification.*

Name	Focus of measurement	No. of items	Scale / response format	Example items
Deferment of Gratification Questionnaire (DGQ) (73)	Deferment of gratification	12	Yes/no; Witt (74) version with 5-point Likert scale from "1 = definitely disagree" to "5 = definitely agree"	*Are you good at saving your money rather than spending it straight away?* *Do you agree with the philosophy: "Eat, drink and be merry, for tomorrow we may be all dead"?*
Multidimensional Delay of Gratification Scale (MDG) (47)	Delay of gratification with 5 dimensions: 1. Personal consumer 2. Academic concerns 3. Career concerns 4. Individual sociopolitical issues 5. Group sociopolitical issues	30	Forced-choice	Personal consumer: *(a) I would rather spend the money I make to buy fashionable clothes now, or* *(b) save the money I make to buy a car in two years' time* Academic concerns: *(a) I would rather stay in school and travel after graduation, or* *(b) take a year off and travel, even if it means falling behind in school*
Academic Delay of Gratification Scale (ADOGS) Adaptation of MDG (75)	Situationally specific academic delay of gratification in a given course	10	Forced-choice; additional rating of strength of choice ("definitely" or "probably")	Paired non-academic and academic alternatives; *Go to a party the night before a test OR Study first and party only if you have time*
Monetary Choice Questionnaire (MCQ) or Kirby Delay Discounting Questionnaire (KDDQ) (76)	Delay discounting, interpreted as impulsivity or self-control	27	Forced-choice (1 of 2 alternatives)	Decisions between two hypothetical amounts of money which differ in size and delay: smaller sum now versus larger sum at a later time: *Would you prefer $34 today, or $50 in 30 days?*
Short Self-Regulation Questionnaire (SSRQ) (54)	Overall self-regulation: 1. Impulse control factor 2. Goal setting factor	31	5-point scale from "strongly disagree" to "strongly agree"	*I am able to resist temptation.* *It's hard for me to notice when I've "had enough" (alcohol, food, sweets).*
Brief Self-Control Scale (BSCS) (55)	Self-control	13	5-point scale from "not at all" to "very much"	*I am good at resisting temptation.* *I spend too much money.*
Barratt Impulsiveness Scale (BIS) (56)	Impulsiveness	30	4-point scale from "rarely / never" to "almost always / always"	*I save regularly.* *I spend or charge more than I earn.*
Future Orientation Scale (43)	1. Time perspective 2. Anticipation of future consequences 3. Planning ahead	15	Choice of best descriptor (forced-choice) and rating of descriptor ("Really true for me" or "Sort of true for me")	Anticipation of future consequences: *Some people would rather save their money for a rainy day than spend it right away on something fun BUT Other people would rather spend their money right away on something fun than save it for a rainy day*
Zimbardo Time Perspective Inventory (ZTPI) (41)	1. Past-negative time perspective 2. Past-positive time perspective 3. Present-fatalistic time perspective 4. Present-hedonistic time-perspective 5. Future time perspective	56	5-point scale from "very untrue" to "very true"	Present-hedonistic – present-orientation (= immediate DoG): *Spending what I earn on pleasures today is better than saving for tomorrow's security* Future orientation (= delayed DoG): *Before making a decision, I weigh the costs against the benefits*

The advantage of these self-report measures is clearly that studies can easily apply them to samples of adults and older people. However, all the approaches to assessing DoG in adulthood described so far depart from the original idea of a behavioral measure of self-control. A further problem of assessing DoG by self-report questionnaires is that responses may be affected by social desirability bias. In other words, respondents may present themselves as having higher ability to delay gratification than is actually the case.

Single behavioral measures of delay of gratification for adolescents and adults

A study of individuals with schizophrenia and controls used a board game for DoG measurement. At designated fields on the board, participants had to decide between two immediate snacks (chocolate drops, gummy bears, or crisps) or continuing to play and receiving double that amount (four delayed snacks) at the end of the game. The authors implemented a large number of trials (70 times two *vs* four snacks) and observed a decrease in impulsive choices over the choice of the game (26).

In sum, most studies on DoG and DD have applied monetary rewards. Some authors used hypothetical money (e.g., 27), others real monetary incentives (e.g., 25). Wulfert et al. (25) highlighted two aspects requiring consideration in experimental DoG studies. First, the incentives offered must be attractive enough to motivate participants. For instance, money is an almost universal incentive. Second, it is important to bear in mind that the amount of a reward and its delay interact dependently (28-30). For example, most people would choose $200 in 20 weeks over $190 in 19 weeks, but $190 immediately rather than $200 in a week's time (31). Thus, in DoG studies, choices between two incentives should include a preference equilibrium at the beginning. In particular, monetary choice tasks should involve varying amounts of money and delay intervals (25).

Comprehensive behavioral measure of delay of gratification in adulthood

The Delay of Gratification Test for Adults (DoG-A) is a more comprehensive behavioral measure of motivational self-regulation which can be applied with adults and older people (32). It consists of four decision tasks involving four different types of rewards – snacks, hypothetical money, real money, and magazines (partly adapted from 25, 26). We refer interested readers to (32) for a comprehensive description of the DoG-A and evaluation and validation results.

EFFECTS OF DELAY OF GRATIFICATION

Numerous studies have investigated the effects of DoG on wellbeing, social behavior, cognitive abilities, and academic success. Although most studies to date have focused on the effects of DoG in children and adolescents, there have been some studies with samples of adults and older people. Table 2 lists their core results.

AGE-RELATED DIFFERENCES IN DELAY OF GRATIFICATION

The ability of patience (e.g., delaying rewards) seems to change across the lifespan. Everyday observations show that people become increasingly patient with age: children are less willing to wait than adults, and even adolescents often react impulsively (33).

To our knowledge, the only existing study to have used a DoG measure to compare different age groups is our own (32). The sample was divided into three age groups of between 60 and 94 years. There was a non-significant trend, the highest DoG being found in the group of those aged 60-69 years, and the lowest in those aged over 80 years. However, there are several studies which used a DD measure.

Comparison of delay of gratification across the lifespan

Green et al. (15) conducted the first study comparing children (mean age: 12 yrs), adolescents (20 yrs) and older adults (67 yrs) with regard to DD choices between

Table 2 - *Effects of delay of gratification across the lifespan.*

Stage in the lifespan	**High DoG as a predictor for … / Correlations of DoG with …**
Childhood	- Attention control (1)
	- Low DoG in children with obesity (77)
Adolescence	- Intelligence (78);
	- Ego resilience, ego control (61);
	- Inhibition, cognitive control (79);
	- Academic and social competencies, self-control, ability to pursue goals (13)
	- Higher discounting rates in adolescents with Attention Deficit Hyperactivity Disorder (80)
Adulthood	- Students: academic performance, motivation, help-seeking, self-efficacy, task-value, goal orientation (75);
	- Intelligence, academic achievement, need for achievement (78, 81);
	- Hemodialysis patients: better health behavior, self-efficacy, compliance (60);
	- Life satisfaction, self-worth (60)
	- Higher discounting rates in pathological gamblers (82), individuals abusing alcohol and drugs (83), antisocial personality disorder (84), obesity (85), schizophrenia (86), traumatic brain injury (87), and social anxiety (88)
Old age	- Motivation regulation, optimism, facets of conscientiousness
	- Satisfaction with life, fewer depressive symptoms, anxiety, hostility, and perceived stress (32)

immediate *vs* delayed hypothetical monetary rewards. The results revealed a lifespan developmental trend: the rate of discounting was highest in children (i.e., low self-control) and lowest in older adults (i.e., high self-control). This quantitative age difference in DD may be attributable to children's lack of experience with long delay, or to their greater impulsivity. The findings support the evolutionary perspective of Rogers (34). However, Read and Read (33) identified some limitations. First, participants came from heterogeneous backgrounds (e.g., undergraduate students *vs* older individuals from a study participant pool). Second, subsample sizes were quite small (12 participants per age group). Third, the researchers did not control for important influencing variables such as gender, socio-economic status, marital status, health status, etc. Most critically, there were no middle-aged participants.

Harrison, Lau and Williams (35) estimated the DD rates of 268 Danish citizens aged between 19 and 75 years. They found a decline of DD with increasing age. Thus, they confirmed the findings of Green et al. (15). In a further study, Green et al. (36) explored the role of age and income in DD (using the same procedure as in their previous study). They compared three groups: 20 younger adults (upper income group; mean age: 33.3 yrs) and 40 older adults equally divided into upper (70.7 yrs) and lower income groups (70.8 yrs). Although the younger and older upper income groups did not differ in terms of DD, the older lower income group had higher DD rates than either the younger or the older upper income groups. Some limitations of this study need to be mentioned: small sample size, unequal distribution of men and women, exclusion of middle-aged individuals and lower income younger adults, and lack of control for influencing factors. Overall, Green at al. (36) could not confirm a systematic decrease in DD from childhood to old age.

Read and Read (33) identified some flaws in the pioneering study of Green et al. (15) and tried to overcome them in a new study investigating DD across the lifespan. First, their study involved 123 participants between 19 and 89 years: not only a young (mean age: 25 yrs) and an old group (75 yrs), but also a middle-aged group (44 yrs). Gender distribution was also equal in all three groups, and the authors controlled for income and wealth as well as for health status and health-related behavior. Read and Read (33) measured several dimensions of DD: first, participants had to choose between immediate smaller *vs* later larger hypothetical amounts of money (DD in monetary choices). The monetary rewards were fixed, but the time-spans varied (e.g., immediate *vs* in 1 year; in 7 *vs* in 10 years). Second, respondents completed a questionnaire by tapping their choices between less holiday earlier and more holiday later (DD in holidays; e.g., 1 day in 1 year *vs* 21 days in 3 years). Third, individuals had to choose between a sooner or later illness (DD in bouts of flu; e.g., 1-day flu immediately *vs* 10-day flu in 1 year). The findings demonstrated that the middle-aged group had the lowest DD rates and that the younger and older individuals discounted most in monetary and holiday choices. The findings did not support the hypothesis of Rogers (34), but are consistent with a theory of Sozou and Seymour (37) (see next section), according to which DoG increases until middle age, after which it decreases steadily with age.

To sum up, some authors report a curvilinear relationship between DD and age (37, 38), middle-aged adults having the lowest discounting rates (high self-control) and younger and older individuals having higher rates (low self-control). Early in life, DD rates are high because the environment still has to be explored and the future is uncertain. In later life, the future again becomes insecure and risky as diverse capacities decline. Relative to Trostel and Taylor (38), the model of Sozou and Seymour (37) hypothesizes a steeper decrease in discounting rates from the age of 40. Both theories are inconsistent with the hypotheses of Rogers (34), who predicts a linear decrease in DD across the lifespan, with no middle-age peak. Taken together, the hypotheses of Trostel and Taylor (38) and of Sozou and Seymour (37) are not independent (33). For instance, the age-related decline in fertility may affect the expectancy of enjoying the pleasure of delayed rewards in the future.

Time perspective and subjective life-expectancy – contribution to evolutionary theories

Green et al. (36) proposed that DoG may become less important as people increasingly see their life expectancy as limited. Although the authors compared various age groups, they did not include measures of subjective life expectancy. As such, they could not analyze this potentially important influencing factor. Time-perspective, a fundamental component in the construction of psychological time, is the result of cognitive processes which divide one individual's experience into past, present, and future temporal frames (39). Subjective life expectancy is the number of years an individual expects to live (40).

Some humans are predominantly present-oriented, others are primarily future-oriented. The former prefer immediate gratification and have less impulse control. The latter focus on delayed gratification – they make choices based on the estimated cost/benefit ratio of a future pleasure or action. They are also better able to control their impulses (41).

Socio-emotional selectivity theory (42) postulates that individuals focus more on the present and less on the future when they realize that the rest of their life is limited. Thus, instead of future payoffs, they focus on making the right choices now. This influences both their decisions and their actions, as they pay more attention to subjective and

intuitive aspects (12). The prioritization of immediate *vs* delayed rewards thus changes with age. If older adults are unsure whether they will benefit from delayed rewards in the future, because they feel that time is running out, they may well favor a certain reward in the present. Behavioral economic models support these ideas: older adults seem to take their subjective life expectancy (number of remaining years) into consideration in economic decision processes. Greater rates of delay discounting are reported in older adults because increasing age implies a higher risk of not surviving to collect a delayed reward (42).

Steinberg et al. (43) focused on age-related differences in future orientation and DD in individuals aged between 10 and 30 years. Future orientation subsumes cognitive, motivational, affective, attitudinal and evaluative constructs, including time-perspective and the degree to which individuals think about their future lives or imagine possible future circumstances (44, 45). The authors measured DD with a monetary choice procedure and future orientation with a newly developed scale (see Table 1). The results showed that adolescents aged between 10 and 13 years describe a weaker future orientation than participants aged 16 and older. First, they more often prefer smaller and sooner to delayed, larger rewards. Second, they describe themselves as less concerned about their future and less likely to anticipate the consequences of decisions. Surprisingly, future orientation and not impulsivity (measured with the Barratt Impulsiveness Scale; see Table 1) significantly mediated the age differences in DD.

CONCLUSIONS

Clinical implications

DoG is an important predictor of various cognitive abilities, motivation to change, health behaviors, and well-being. With respect to health behavior, DoG plays a decisive role in, for example, the decision to abstain from excessive sunbathing in order to reduce the risk of contracting skin cancer in old age, or to engage in regular exercise to keep fit and healthy. DoG may also be essential in maintaining health behavior – a fact which may be exploited by programs promoting health-related behavior. In addition, DoG is not only important in the field of primary prevention. The success of secondary and tertiary prevention also depends on self-regulated behavior – for example, in minimizing the negative effects of chronic diseases such as rheumatism, hypertonia, diabetes, HIV and COPD. In sum, compliant behavior reduces costs for social insurance systems.

Reasons for lack of delay of gratification studies in adulthood and old age

Why have DoG studies to date largely neglected adulthood and old age? One answer is simply that the original continuous measure of DoG is only suitable for children. Mischel's original DoG paradigm (the "marshmallow test", 46) is of limited, if any, value for studies with adolescents and adults, because the delay intervals were adapted to children's experience and perception of time, and thus span only a few minutes. In contrast, studies with adults require both meaningful DoG intervals (days or weeks) and meaningful rewards. Assessment of DoG by self-report questionnaires may produce biased results, due to the problem of social desirability (25). It is only recently that an age-appropriate DoG test has been developed by the present authors (32).

Several studies have focused on DD from childhood to old age, most of them using hypothetical monetary choice procedures which have gained broad acceptance in psychological and economic research. Although DoG is a multidimensional construct (47, 48) which may differ from domain to domain, it is still unclear whether low DD rates imply a general preference for delayed rewards. In fact, in a study with the newly developed DoG test, the snacks score proved to be the best indicator of wellbeing, although the various reward types had low-to-medium intercorrelations (32). By the same token, a factor analysis in a study with college student leaders showed that DoG could be divided into dimensions such as achievement orientation and career objectives (47). Similarly, the concept of academic DoG limits DoG to that context (achievement of academic rewards). Experimenters must also bear in mind that DoG is highly dependent on the situation (e.g., 21). Nevertheless, a general factor of DoG may also make sense, because individuals can potentially exhibit high DoG in many dimensions. For example, one individual may show high academic DoG and high DoG in health behavior. Moreover, there is little evidence to support the idea of DoG as an ability which is both learned and generalized across situations (8, 49). Several authors have emphasized that the DD task is an indicator of actual decisions, as DD rates do not differ between real and hypothetical monetary rewards (50-52).

Another reason for the neglect of DoG studies in adulthood may be that self-regulation can easily be measured with self-report questionnaires such as the Volitional Components Inventory (VCI; 53), Short Self-Regulation Questionnaire (SSRQ; 54), Brief Self-Control Scale (BSCS; 55) or Barratt Impulsiveness Scale (BIS; 56). Executive functions have also been broadly examined in impaired and unimpaired older adults. Diverse measures are applicable, depending on the domain of executive functioning: for example, task switching (Trail Making Test - Part B; 57) or inhibition of predominant responses (Stroop Color-Word Test; 58).

Does the ability to delay gratification decrease or increase with age?

On one hand, the ability to self-regulate seems to be stable across the lifespan (25). Some authors have suggested

that DoG likewise takes shape in childhood and remains robust in later life (59-61). On the other hand, changes in the ability to delay gratification across the lifespan are obvious and observable in everyday life: young children are more impulsive and impatient, whereas adults and older individuals are more patient, better able to resist their impulses, and more willing to wait (33). In other words, possible long-term consequences weigh more heavily and seriously for adults. Neuropsychological evidence supports these ideas: the frontal lobe regions ("cold" system) mature as children grow up, whereas the "hot" system is already fully developed (62). However, as older individuals become aware of the limited time available to them, they may come to behave "like there's no tomorrow" (36). Thus, the variables of time-perspective and subjective life expectancy give new impetus to evolutionary theories, and may help to explain why DoG may decrease in adulthood and old age. In addition, neuropsychological evidence suggests that DoG may decrease in both unimpaired and impaired older adults – for example, in individuals with dementia, a disease with dramatically increasing prevalence rates (63). Empirical findings point to relations between executive functions, DoG, and frontal functioning (64-66). In normal aging, there is a neural loss in the prefrontal cortex (67, 68). Neuropsychological behavioral evidence also describes a decline in executive functions with advancing age (e.g., 69). Individuals with dementia also have significantly more deficits in executive functions than unimpaired controls (e.g., 70). In sum, there is a need for validated DoG measures for application in adults.

Potential future studies of delay of gratification

First, longitudinal analyses could investigate stability *vs* changes in DoG across the lifespan. Second, the possible protective effects of DoG on health, wellbeing and satisfaction with life in adulthood and old age warrant more detailed investigation. Third, further studies should examine whether DoG helps to protect against cognitive decline. Specifically, high DoG may result in high cognitive and motivational reserves. Whereas cognitive reserve helps the human brain to cope with impairment through activation of pre-existing cognitive resources and compensatory mechanisms (71), motivational reserve refers to motivational aspects of cognitive aging (72). For instance, individuals with high DoG across the lifespan may show higher educational and occupational attainment – two indices of cognitive reserve (71). DoG is a behavioral measure of motivational abilities which are discussed as protective factors in emotional and cognitive health (72).

Fourth, the neural substrates of DoG are also worth exploring. Structural MRI studies could further examine the relationship between DoG and the frontal lobes. Functional MRI studies could contribute to elucidating activation patterns in decisions for immediate *vs* delayed rewards.

Lastly, as difficulty in delaying gratification and self-regulating is seen as maladaptive, immature and irrational (e.g., 15), implications for practice include the development of interventions to enhance DoG. Inasmuch as DoG is a crucial ability associated with numerous competencies and qualities, various open questions warrant investigation here. For example, research could explore the benefits of DoG modifications in different age groups and as a predictor of diverse outcomes across the lifespan.

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